Space Weather Technical Forecast

Issued on Saturday, 18 November 2023 at 13:31 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-Class flares throughout the period. Slight chance G1/Minor Geomagnetic Storm late Day 2 or early Day 3 (19-20 Nov).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate over the past 24 hours, with the background level X-ray flux gradually increasing to C-class levels. The largest flare was an impulsive M1.2 at 18/0542 UTC, thought to originate from a region just beyond the northeast limb. There are three regions on the visible disc, AR3486 (Cao/beta), which will soon rotate beyond the western limb. AR3489 (Dao/Beta) continues to emerge from the eastern limb and is showing signs of development on its trailing portion. The only other region on the visible disc is newly emerging in the northeast. All regions appear to be currently stable but hard to analyse, due to their proximity to the limbs.

There have been several CMEs observed on imagery over the last 24 hours, a filament lift-off from the southwest may have an Earth-directed component but awaits modelling by Enlil.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1, have remained at slow-ambient levels throughout, around 300-350 km/s, and are currently about 300km/s. The phi angle was predominantly positive (away from the Sun), but became negative (towards the Sun) around 18/0700 UTC. Density has largely remained below average, with a brief period at average levels around 18/0500 UTC. The IMF (Bt) was weak, at or below 5nT. The north-south component (Bz) has weakly fluctuated throughout, between -4 and +2nT. The resulting geomagnetic activity was Quiet (Kp 0-1).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at Background levels. GOES16 high energy (greater than 2MeV) electron flux was predominately moderate throughout the period, with a peak of 341 pfu at 17/1440 UTC. The associated 24-hour fluence has remained relatively steady and below the Active threshold (1e8 integrated pfu) threshold. The fluence observation at 18/0001UTC was 1.08e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low, but with a chance of isolated M-class flares emanating from the region on the southeast of the disc or new or returning regions that are expected to rotate onto the visible disc through the forecast period.

Solar Wind / Geomagnetic Activity: The CME associated with the 16/0100 UTC filament eruption may reach Earth late Day 2 (19 Nov) or early Day 3 (20 Nov), but confidence is low regarding this and any geomagnetic response.

The solar wind is expected to remain at predominantly background levels, perhaps increasing to slightly elevated from late Day 1 due to weak high speed stream influence, from a narrow coronal hole feature in the western hemisphere.

Geomagnetic activity is expected to be Quiet (Kp 0-2) at first with Unsettled (Kp 3) periods increasingly likely from late Day 1 to Day 3 (18-20 Nov). Slight chance of Active (Kp 4) intervals or an isolated G1/Minor Geomagnetic Storm (Kp 5) late Day 2 (19 Nov) or early Day 3 (20 Nov)

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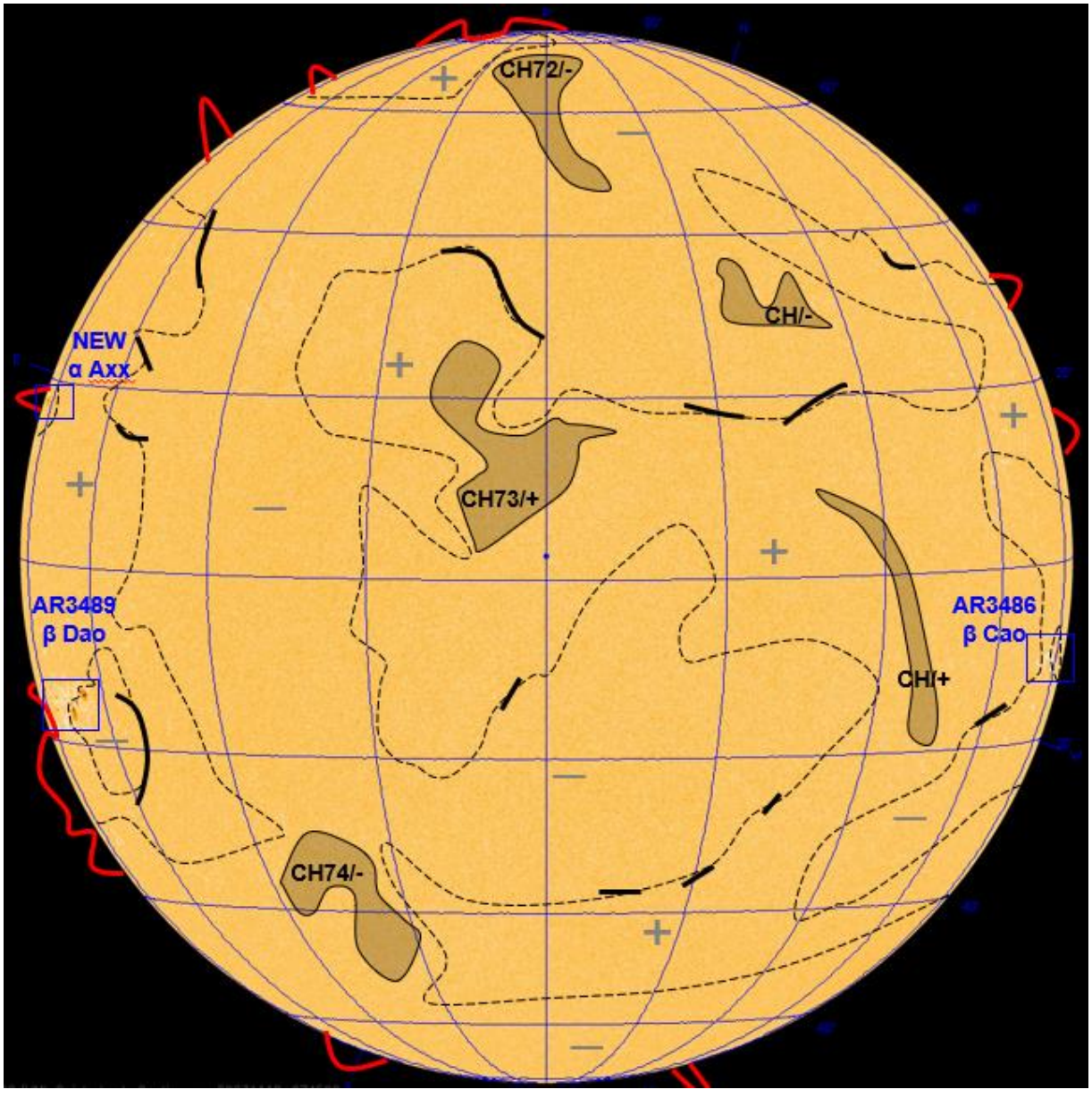
associated with the potential arrival of a CME. Low confidence in details surrounding this feature.

Energetic Particles / Solar Radiation: GOES16 High energy proton flux is expected to remain at Background levels. GOES16 High energy electron flux is expected to be mostly moderate, perhaps seeing diurnal peaks at High levels during the period. The potential CME arrival late Day 2 (19 Nov) or early Day 3 (20 Nov) and associated geomagnetic activity may suppress observed flux levels to background during Day 3. The associated 24-hour electron fluence is expected to remain below the Active (1e8 integrated pfu) level, but perhaps with a gradually increasing trend.

Figure 1. Solar Analysis Valid 18/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The CME associated with the 16/0100UTC filament eruption may reach Earth late Day 2 (19 Nov) or early Day 3 (20 Nov) with low confidence in the arrival time and potential effects. MOSWOC Enlil ensemble is showing a range of arrival times as well as differing modelling of the trajectory, with the possibility of a more direct hit rather than the expected glancing blow. Other recent CMEs are not thought to be Earth-directed, however, a filament lift-off from the southwest disc at 18/0500 UTC is yet to be analysed by Enlil.

The solar wind is expected to remain at predominantly background levels. Winds may increase to become slightly elevated later Day 1 due to coronal hole influence from a narrow coronal hole feature in the western hemisphere. The influence of this thin coronal hole is likely to wane later in the period. Met Office SWPM is thought to provide reasonable guidance.

Geomagnetic activity is expected to be Quiet at first (Kp 0-2) then from late Day 1 (18 Nov) to early Day 3 occasional Unsettled (Kp 3) intervals are possible. There is a slight chance that the CME arrival late Day 2 or early Day 3 may produce Active (Kp 4) intervals or an isolated G1/Minor Geomagnetic Storm (Kp 5). This risk decreases to by Day 4 (21 Nov) in the absence of further CMEs or HSS influences.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	15	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/1100 UTC	Partial	Filament Eruption	NW	400 km/s	19/2000 UTC	Low confidence.

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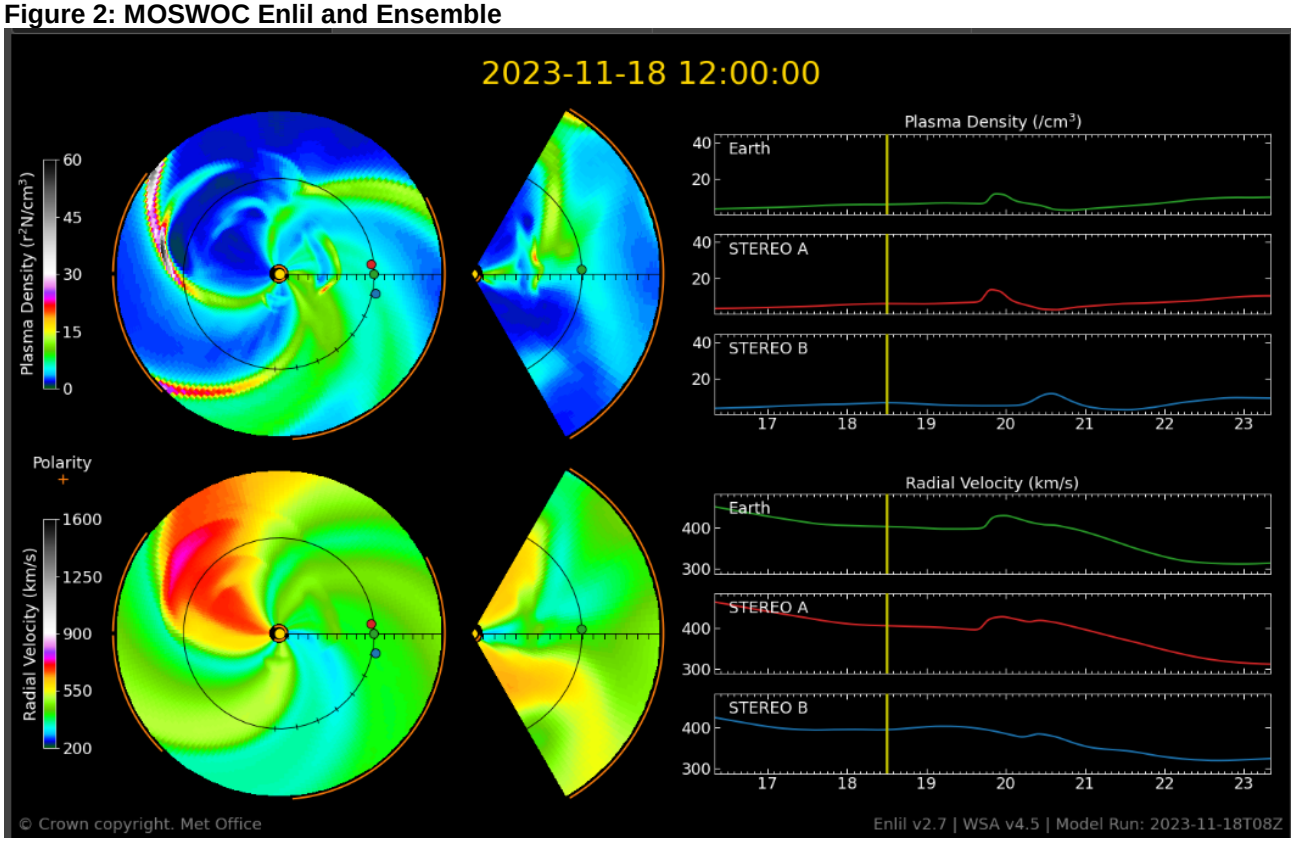
Figure 2: MOSWOC Enlil and Ensemble



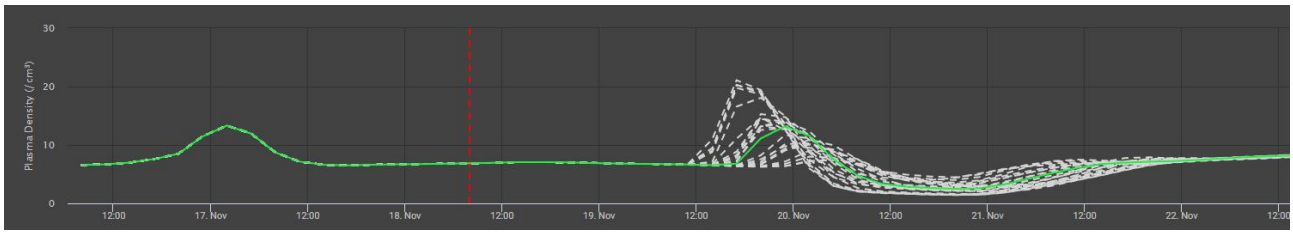
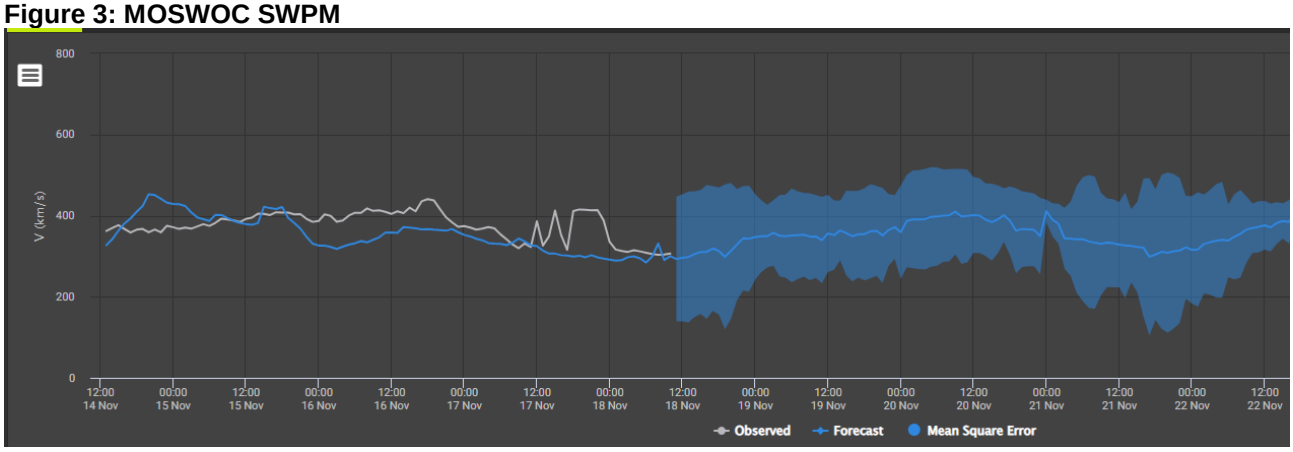


Figure 3: MOSWOC SWPM



Radio Blackouts - X-Ray Flares:

There are currently three sunspot regions on the visible disc. AR3486 (Cao/Beta), close to the western limb appears relatively stable and is due to rotate off of the disc during the next 24 hours. The largest region on the disc, AR3489 (Dao/Beta) continues to emerge from the southeast limb. The polarity of the regions remains difficult to ascertain close to the restricted viewing angle, but the trailing portion appears to be of opposite polarity. The newly emerging

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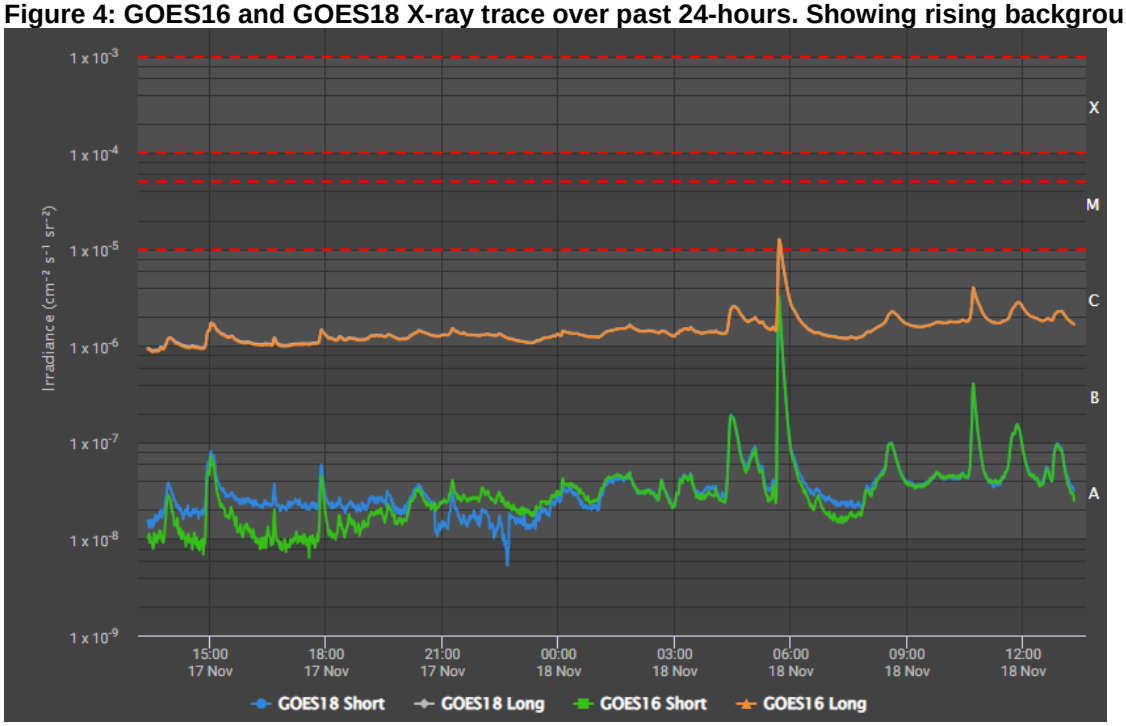
region in the northeast is currently classed as Axx/Alpha, but may form part of a larger region that far-sided seismic analysis would suggest is due to rotate onto the disc during Days 1-2 (18-19 Nov). Far-sided analysis and bright regions on SDO AIA/0094 support the potential of a further region returning to or emerging onto the visible disc later Day 2 (19 Nov).

Moderate activity has been observed over the last 24 hours, with the background flux level now at C-class. The largest flare was a M1.2 peaking at 18/0542 UTC from beyond the northeastern limb. The new regions in the east, and the regions set to emerge over the coming days are reflected in the elevated probability of further isolated M-Class flares and associated R1/Minor Radio Blackouts.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	40	40
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 4: GOES16 and GOES18 X-ray trace over past 24-hours. Showing rising background trend.



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at background levels. Filament eruptions may cause an increase in the proton flux, although these are expected to remain below the S1/Minor Solar Radiation Storm level. Following the M1.2 flare from a region just beyond the eastern limb there was a slight response in proton flux levels. As such, and with the anticipated arrival and development of sunspot regions on the eastern disc through the coming days, the probabilities have been raised slightly.

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Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

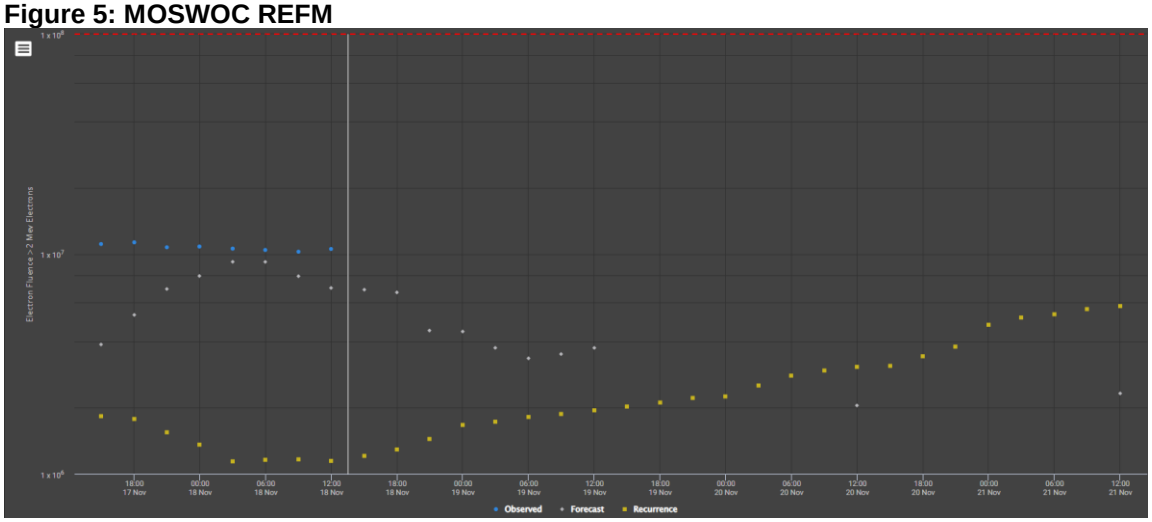
High Energy Electrons Event (≥ 2MeV):

GOES16 High energy electron flux is expected to continue at moderate levels today, perhaps seeing a diurnal peak at high levels. This is more probable on Day 2 (19 Nov) due to the forecast arrival of a weak high speed stream from the narrow coronal hole feature on the western disc. The potential CME arrival late Day 2 or early Day 3 (20 Nov) and associated geomagnetic activity may see flux levels become suppressed to background. Recovery of flux levels is than anticipated by Day 4 (21 Nov) with a period of High during the peak of the diurnal cycle.

The associated 24-hour electron flux is expected to remain below the Active (1e8 integrated pfu) level with a generally increasing but fluctuating trend following uncertain geomagnetic activity Days 2-3 (19-20 Nov). The REFM model shows the fluence remaining below the Active threshold, which is accepted. The REFM model otherwise not providing much of a steer.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	10	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC REFM



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